

Language, race, and vowel space: Contemporary Californian English*

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1 Introduction

California is a populous, ethnically diverse state with high percentages of residents claiming Asian, Pacific Islander, Native American, Latino, and/or Hispanic heritage. Individuals of Asian and Latin American descent comprise a large portion of California's population: 14.4% and 38.6%, or twice and three times the national average, respectively.¹ Nearly 44% of Californians are native speakers of a language other than English, and of those speakers, 74% speak English natively, meaning that they were raised multilingually (Modern Language Association, 2010). In California, languages other than English frequently spoken in the home include Spanish, Mandarin, Cantonese, Tagalog, Vietnamese, Korean, and Persian (Farsi). While roughly 20.7% of households in the United States report speaking a language other than English in the home, 43.7% of California households report the same (United States Census Bureau, 2010).

Studies of Californian English have assumed historical leveling (given California's long history of White immigration from other parts of the United States), but have also demonstrated the rise of certain phonological patterns distinct to California. Investigations into Californian English began in earnest with the 1986 seminar that first proposed the California Vowel Shift (Hinton et al., 1987; Luthin, 1987) by comparing vowel qualities in contemporaneous elicitations to those described in Reed's Linguistic Atlas of the Pacific Coast (1952). Subsequent research has confirmed the California Vowel Shift among White Californians in urban and rural locations (Hagiwara, 1997; Podesva et al., 2015a), debated the presence of its features in Chicano English (see Fought, 1999; Eckert, 2008a), and connected its use to gender identity (Kennedy and Grama, 2012) and the indexing of a gay male persona (Podesva, 2011).

Despite this work, the majority of research on the California Vowel Shift reports on the speech of White Californians. Less attention has been given to English speakers who self-identify as non-White Hispanic, Black, Asian, or Native American. In the earliest studies, Asian American speakers in particular were generalized into the 'Anglo' category. However, more recently some studies have examined differences in vowel quality by ethnicity, including Mendoza-Denton and Iwai (1993), who compared Japanese Americans and White Americans, and Hall-Lew (2011), who found evidence that Asian-identifying San Franciscans may be leading a change that marks the California Vowel Shift (/u/-fronting).

1.1 The California Vowel Shift

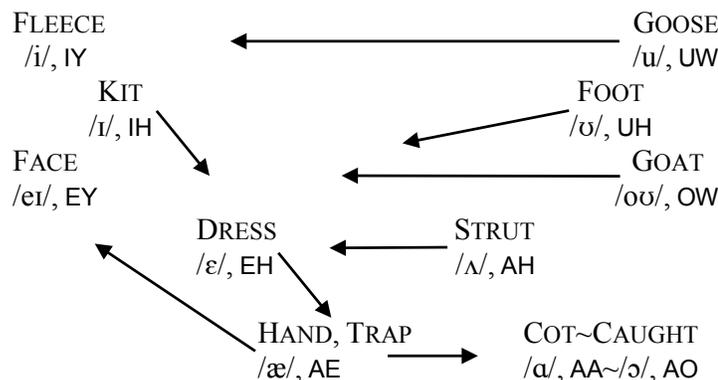
The California Vowel Shift (CVS), as evidenced by historical and contemporary studies of the English spoken by ethnically Caucasian, Asian, and Latino residents of California, is most marked by fronted back vowels /u, ʊ, ʊʊ/, lowered and backed lax front vowels /ɪ, ε/, and the merger of low back vowels /ɑ/ and /ɔ/ (the COT-CAUGHT merger). As a whole, this resembles a counter-clockwise shift in the vowel space: back vowels front, lax front vowels lower, and low front vowels

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¹Demographic information taken from the US Census acknowledges that 'Asian' is a race and 'Hispanic or Latino' are ethnic categories, so some overlap for Californians who identify as both Asian and Latino is possible.

open and back. In addition, the low front vowel /æ/ is subject to a phonologically-conditioned split: raising and fronting before coda nasal consonants (HAND-raising, as in *lamb* or *handstand*), while lowering and opening elsewhere (TRAP-backing). (1) illustrates CVS; IPA transcription, representative English words, and ARPABET encoding for each vowel are provided.

(1) *California Vowel Shift, adapted from Hall-Lew (2009)*



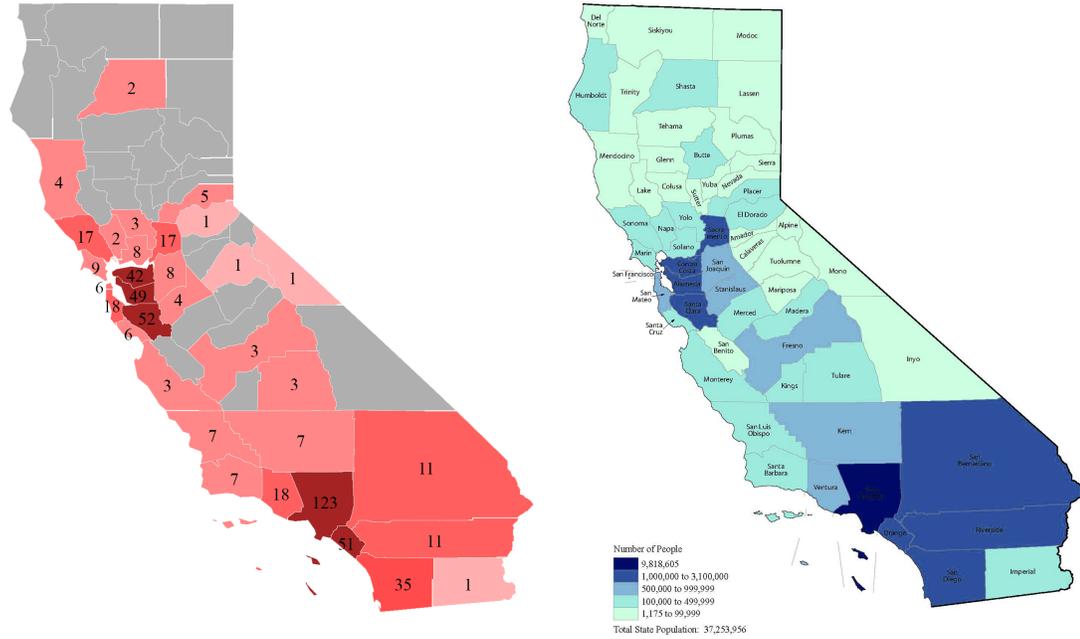
Social attributes of speakers such as ethnicity, class, and social network structure may affect the degree of CVS-related shift observed, regardless of (or in addition to) a speaker’s age (see Fought, 1999; Eckert, 2008a; Podesva, 2011; Podesva et al., 2015b). In light of California’s considerable population diversity, this effect is potentially under-investigated. The current study aims to address how the ethnic group membership of Californians mediates adoption of CVS characteristics, at the level of self-identified ethnic group membership. This large-scale analysis of a broad, diverse population may permit better assessment of CVS and allow us to approach some of the traditional assumptions of dialectology and sociophonetics in a new light.

2 Methods

2.1 The Voices of Berkeley Corpus

The Voices of Berkeley project (Johnson and Sprouse, 2011) collected speech samples from 786 incoming university students, aged 16 to 61 (mean: 19, median: 18); all volunteered and gave informed consent. Participants were asked to provide basic demographic information, most importantly self-determined ethnicity (SDE). This field was open-ended (i.e. not a checkbox or multiple-choice question). Also included in participant-provided metadata were age, gender, place of residence (country, state, county, city), languages spoken (up to four) and estimated age of acquisition, the occupations of up to two caregivers and up to four ‘grandparent’ caregivers, and caregivers’ native languages. Participants originated from around the United States and a number of other countries. A total of 535 (354 F) speakers were from California and gave sufficient demographic information to include in the finished data set. This group’s stated Californian counties of residence roughly align with the population distribution of California from the 2010 Census (see the figure in (2)).

- (2) *Left: number of study participants by California county. Right: population density of California by county (US Census Bureau). Darker colors indicate larger population.*



Audio recording was performed by participants using their own personal computers (with a built-in microphone and Internet access), which enabled the logging of geographic location in latitude and longitude at the time of participation. Stimuli were six simple sentences (see Appendix A) designed to elicit the use of several vowels relevant to expression of CVS characteristics. Participants were shown each sentence and then given unlimited opportunities to practice and record the sentence before moving on to the next sentence.

2.2 Participant demographics

- (3) *Voices of Berkeley SDE groups (n=506)*

White (WHT)	Latino (LAT)	Chinese (CHN)	Korean (KRN)
158 F	49 F	53 F	14 F
82 M	37 M	17 M	10 M
Mid. Eastern (MDE)	South Asian (SOU)	Vietnamese (VTM)	Filipino (FLP)
14 F	12 F	8 F	6 F
7 M	4 M	4 M	4 M
Hapa (HAP)	Black (BLK)	Japanese (JPN)	Native Am. (NDN)
7 F	6 F	5 F	4 F
2 M	2 M	1 M	0 M

Californian participants were sorted into twelve SDE groups in (3) based on their response and the experimenters' reasoning. For example, participants who reported 'White', 'Caucasian', or a combination of European heritages such as 'Irish/German' were categorized as 'White'. 'Chinese' and 'Chinese American' were both considered 'Chinese'—keeping in mind that all participants were Californian. Participants who identified as mixed-race Asian and European were combined into a 'Hapa' SDE group. Other participants who responded in ways not conducive to by-group statistical analyses—particularly nonspecific 'multiracial' responses—were excluded from analysis. Of the remaining 506 participants, 44.9% identify as White, 28.4% as Asian (inclusive of East

Asian, Southeast Asian, South Asian/Indian, and Middle Eastern), and 15.5% as Chicano, Latino, and/or Hispanic. The table in (4) compares these percentages to the racial/ethnic compositions of the UC Berkeley undergraduate student body and the state of California.

(4) *Voices of Berkeley participant demographics*

	Californians in VoB		UCB census		CA census
White	44.9%	(240)	30%	(7,746)	73.2%
Asian	28.4%	(152)	39%	(10,145)	14.4%
Chicano/Latino, Hisp.	15.5%	(83)	12%	(3,136)	38.6%
Black/Afr. American	1.5%	(8)	3%	(892)	6.5%

Participants identified up to four non-English languages that they speak. 165 (106 F) Californian speakers identified English, and no other language, as their L1. The next most common languages listed as L1 or L2 were Spanish, Mandarin, Korean, Cantonese, Farsi, Vietnamese, and Hindi. No participants listed a non-English language as their only language (i.e. all participants spoke English).

Due to the ambiguity inherent in asking for ‘first language’ and ‘second language’ in a forced-choice survey of this kind, the ‘L1’/‘L2’ distinction in participants’ responses was collapsed. For example, a speaker who identified Cantonese as their L1 and English as their L2 and a speaker who identified English as their L1 and Cantonese as their L2 were put into the same category. In this way, all speakers could be categorized as English monolinguals or bilinguals of English and some other language. However, participants who listed Spanish as an L2 were not included in the ‘bilingual’ categorization, due to the frequency of Californian students learning Spanish in school and not (or at least rarely) attaining true bilingualism.

2.3 Acoustic analysis

Each recording was screened by one or more trained phoneticians for audio quality. Usable recordings were automatically given ARPABET transcriptions with the Penn Forced Aligner (Rosenfelder et al., 2011). Using an Inverse Filter Control method (Ueda et al., 2007), measurements for F1 and F2 were taken at eight evenly-spaced time points through the duration of each vowel token. Formant measurements were logmean-normalized by gender (Adank et al., 2004).

The F1–F2 measurements were subjected to two types of analysis of variance: a smoothing-spline (SSANOVA) model (Davidson, 2006; Nycz and de Decker, 2006) that sought effects of SDE group on F1 and F2, as well as interaction effects of time point and SDE group on F1 and F2, and a one-way repeated measures ANOVA. For the SSANOVA, group effects model the impact of SDE group membership on vowel quality when compared to the average formant contours of the entire California group for that vowel, and interaction effects model time-varying impact of SDE group on vowel quality compared to this hypothetical average contour.

3 Results

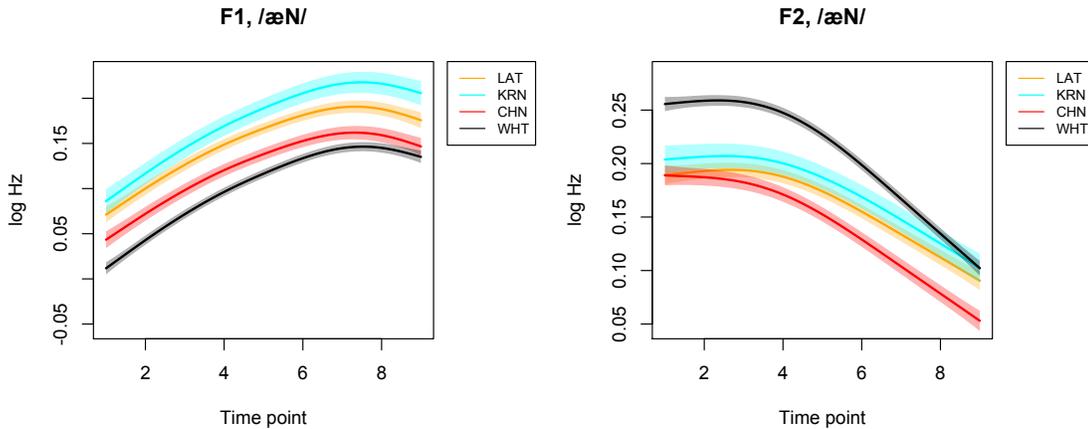
In Sections 3.1 through Section 3.4 we report effects from the SSANOVA model, focusing on the largest SDE groups and on group and interaction effects from the model that meet a $p < 0.05$ threshold of statistical significance.

3.1 Model results: /æ/

The observed pattern for the low front vowel /æ/ is, in keeping with previous studies of the CVS, a phonologically conditioned split depending on the presence of a nasal consonant coda. (We will refer to this pre-nasal variant of /æ/ as /æN/.) A clear effect of SDE group, as well as an interaction of group and time point, can be seen in the F1 and F2 values for /æ/ in this study. However, different SDE groups show different patterns of greater or lesser advancement in the direction of each vowel variant’s CVS-related changes.

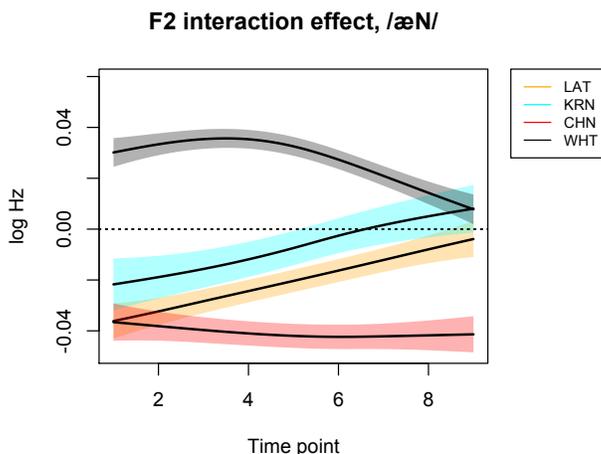
(5) plots SSANOVA splines for the F1 and F2 trajectories of /æN/ across the eight time points, with the 95% confidence interval represented by the shaded region surrounding each line. Group formant values of significant difference at the $p < 0.05$ threshold are indicated by non-overlap of these confidence intervals. Thus, for example, the LAT group has a significantly higher F1 value for /æN/ (indicating less tongue body raising for this vowel) than the WHT group. The KRN and CHN SDE groups are also shown to have higher F1 than the WHT group, as well as lower F2 (less fronting).

(5) *Normalized F1 (L) and F2 (R) log mean of /æN/ over time: LAT, KRN, CHN, WHT*



Overall, the WHT group (as well as BLK, not pictured) shows a more fronted /æN/ than other SDE groups. Of particular interest in (5) is the trajectory of WHT’s F2 over time. In the first half of the vowel, WHT mean log F2 is above average: greater than the LAT group’s values. However, the vowel’s trajectory does not run parallel to the other three groups’, and by time point 8, the F2 value for the WHT group has fallen significantly, matching the value for LAT, KRN, and other ethnic groups. We expect all groups to exhibit the generalized formant trajectory illustrated here, since the HAND vowel is generally slightly diphthongized in this phonetic context, but the WHT group’s diphthongization also appears to be the greatest of all SDE groups. This distinction can be seen in the SSANOVA model’s by-group interaction effects for F2 of /æN/ in the figure in (6).

(6) *Interaction effect for selected SDE groups and time point of vowel for F2 of /æN/*



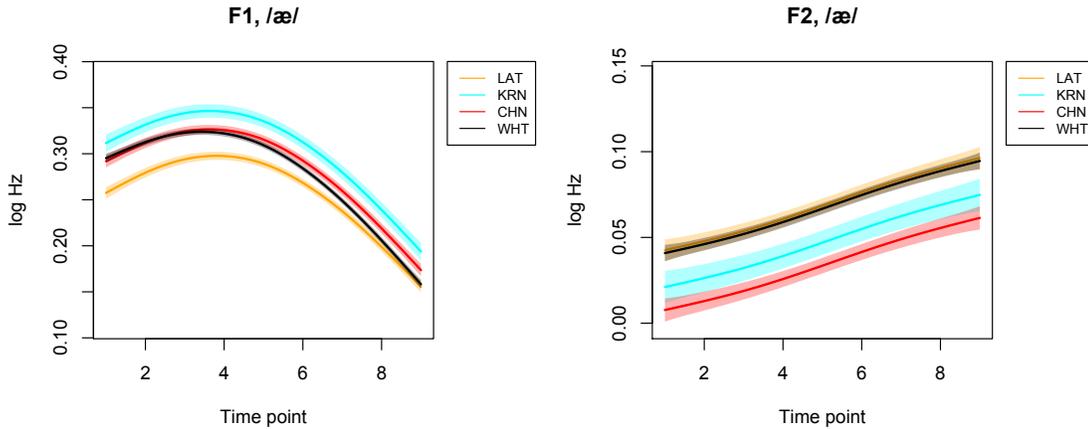
(7) summarizes the direction of group effects for HAND-raising: if ‘Average’, a group effect does not fall outside one standard error of an effect size of 0. For this particular vowel, lower F1 and higher F2 indicate a raised and fronted HAND-vowel, and thus greater participation in this particular aspect of CVS. The LAT and KRN groups consistently ‘lag’ in this change—that is to say, their tokens of this vowel were less raised than the average for the corpus. BLK and WHT groups consistently ‘lead’ the change. It is important to note that the model results are relative to overall CVS observed among all Californian speakers, not relative to any outside standard of American English vowel formant measurements.

(7) *Participation in /æN/ changes for selected SDE groups*

	Lag (hi F1, lo F2)	Average	Lead (lo F1, hi F2)
/æN/ F1 (raising)	LAT, KRN	CHN, VTM	NDN, BLK, WHT
/æN/ F2 (fronting)	LAT, KRN, CHN	VTM, NDN	BLK, WHT

The counterpart to HAND-raising in CVS is the lowering and backing of /æ/ in non-pre-nasal contexts, which we refer to as TRAP-backing. In this case, a higher F1 and lower F2 indicate more participation in the established CVS changes. SSANOVA splines for F1 and F2 trajectories for selected SDE groups are provided in (8) for /æ/ in non-pre-nasal contexts.

- (8) *Normalized F1 and F2 log mean of non-pre-nasal /æ/ over time: LAT, KRN, CHN, WHT*



In comparison to its distinct profile for HAND-raising, the WHT group does not appear to be the one with the most advanced change. The groups that actually appear to exhibit TRAP-backing (‘leading’ in the nomenclature introduced for (7)) are KRN, CHN, and NDN. The VTM group leads in lowering (F1-related), but lags in backing (F2-related), while the BLK and LAT groups consistently lag behind the other SDE groups in these dimensions. These findings are summarized in (9) below.

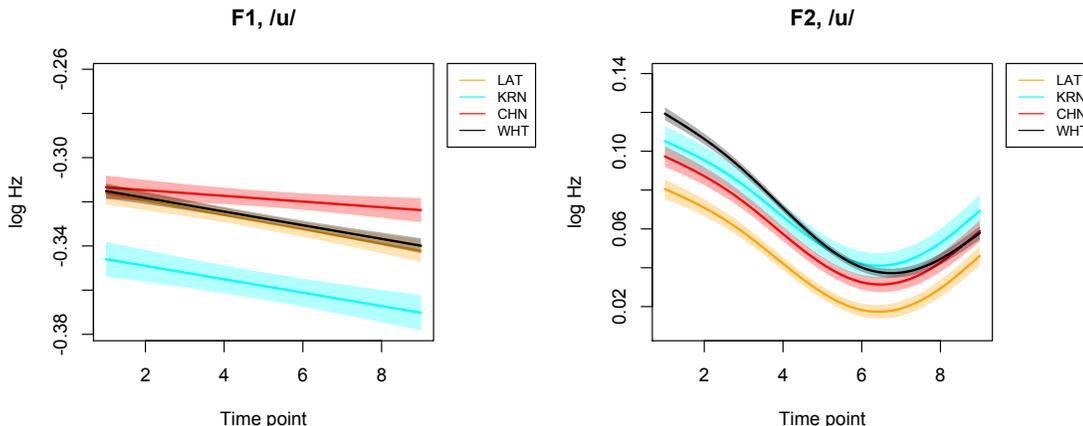
- (9) *Participation in /æ/ changes by SDE group*

	Lag (lo F1, hi F2)	Average	Lead (hi F1, lo F2)
/æ/ F1 (lowering)	LAT, BLK, WHT	CHN	VTM, KRN
/æ/ F2 (backing)	LAT, BLK, VTM, WHT		CHN, KRN, NDN

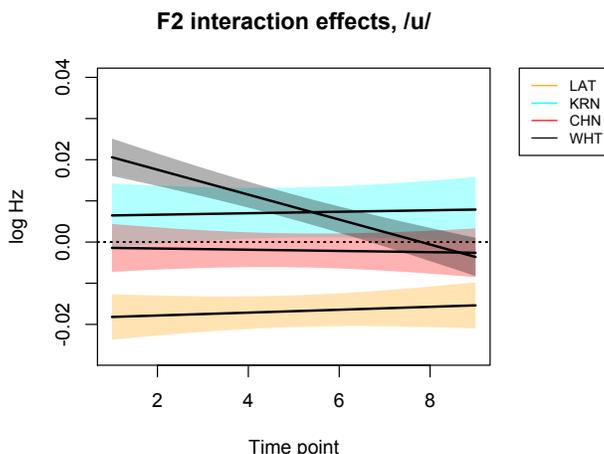
3.2 Model results: /u/ and /ou/

The previously established CVS pattern of back vowel fronting for /u/ and /ou/ is present for speakers of this study, and there are interesting and significant interaction effects for /u/ in the SSANOVA model. (10) below plots the SSANOVA splines for /u/’s F1 and F2 trajectories across all time points. LAT speakers exhibit by far the lowest F2 values, indicating the least fronted /u/ among the study population. KRN speakers exhibit significantly higher F2 compared to WHT speakers, except in the second half of /u/. There is also a significant difference in F1, or the height of /u/, when comparing WHT or LAT speakers to KRN speakers (as well as BLK and VTM, not pictured). These group-dependent differences in /u/’s F2 trajectory are captured by the appropriate interaction effects from the SSANOVA model in (11).

(10) *Normalized F1 and F2 log mean of /u/ over time: LAT, KRN, CHN, WHT*



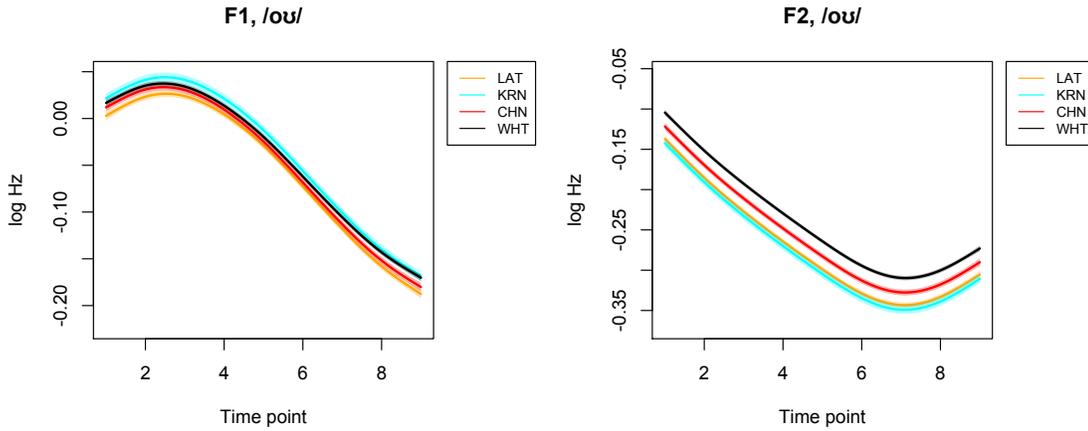
(11) *Interaction effect for selected SDE groups and time point for F2 of /u/*



As a group, the SDE groups of BLK, KRN, and WHT exhibit globally higher F2 values for /u/. However, CHN, and especially LAT and VTM speakers, have much lower global F2 values. Furthermore, as (10) demonstrates, the contours of these vowels also differ. These results suggest that there may be two distinct /u/ variants present in members of the study population, analogous to the differently diphthongized variants found in Koops (2010).

As for /oʊ/, (12) presents this vowel’s trajectory data as SSANOVA splines. Unlike /u/-fronting, some group effects for both formants are significant, but no interaction effects reach significance; that is, all groups have similarly shaped F1 and F2 trajectories at different global formant levels. The NDN SDE group (not pictured) has the largest magnitude of F2 advancement. WHT and BLK speakers also exhibit overall high F2 levels, while LAT speakers show the lowest F2 values. In addition, while KRN speakers lead in /u/-fronting, they are shown here to lag in /oʊ/-fronting. A summary of back vowel fronting for all SDE groups run through the SSANOVA is presented in (13).

(12) Normalized F1 and F2 log mean of /ou/ over time: LAT, KRN, CHN, WHT



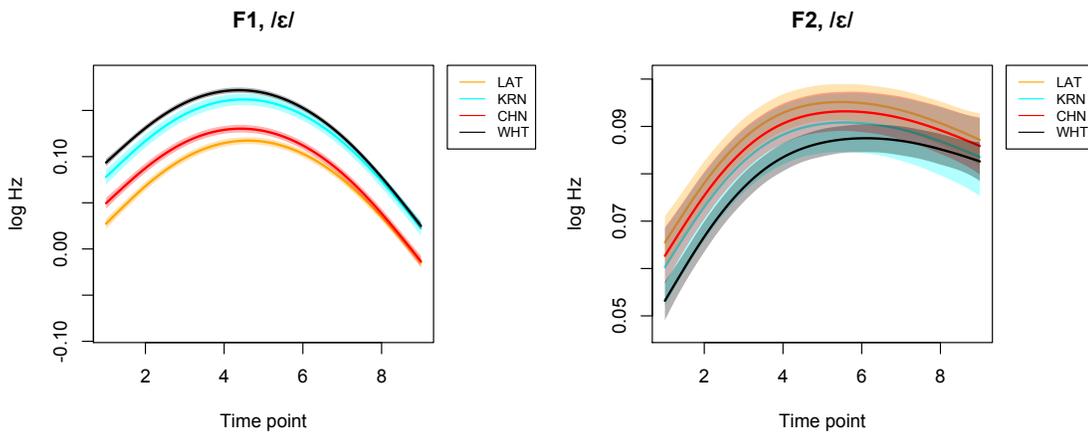
(13) Participation in back vowel fronting by SDE group

	Lag (lo F2)	Average	Lead (hi F2)
/u/ F2 (fronting)	LAT, VTM	CHN, BLK	KRN, WHT, NDN
/ou/ F2 (fronting)	LAT, KRN	CHN, VTM	BLK, WHT, NDN

3.3 Model results: /ε/

In CVS, the front lax vowels /ɪ/ and /ε/ are backed and lowered. Our SSANOVA model was not run on the /ɪ/ vowel due to insufficient tokens, but it did find significant group effects in F1, corresponding to vowel height, for the DRESS vowel. (14) below shows that across all time points of /ε/, LAT and CHN speakers and the BLK group (not pictured) have lower F1 values and correspondingly less lowered tokens; they participate in lowering to a lesser degree than a typical White speaker.

(14) Normalized log mean of F1 and F2 of /ε/ over time: LAT, KRN, CHN, WHT



3.4 Summary of SSANOVA results

(15) lists seven² of the twelve SDE groups used to generate the SSANOVA model and their results regarding more or less advanced participation (+), average participation (0), or lagging participation (-) in certain formant value changes characteristic of CVS. These results are taken from the raw data for group effects, not interaction effects or statistical tests run on the model. A score of (+) or (-) represents a difference of at least one standard error away—positive or negative, respectively—from an effect size of zero. Generally, the average LAT speaker can be taken to participate less in the examined aspects of the CVS, while the average WHT speaker participates more. The CHN, KRN, and VTM groups vary in their participation in CVS, but tend to participate less, depending on the vowels in question.

(15) *Participation in certain vowel changes of CVS by self-determined ethnicity group*

SDE	/æ/ hi F1	lo F2	/æN/ lo F1	hi F2	/u/ hi F2	/ou/ hi F2	/ε/ hi F1
LAT	-	-	-	-	-	-	-
CHN	0	+	0	-	0	0	-
BLK	-	-	+	+	0	+	-
VTM	+	-	0	0	-	0	0
KRN	+	+	-	-	+	-	+
NDN	-	+	+	0	+	+	0
WHT	-	-	+	+	+	+	+

3.5 ANOVA results

To confirm the findings of the SSANOVA model, additional one-way repeated measures ANOVAs were run on the vowels that undergo specific changes within CVS. These models were run on the same normalized formant data as the SSANOVA model and tested for effects of ethnicity, background language, and caregiver language on vowel quality. However, the ANOVAs were only run on one time point of the vowel (time point 5, at 50% of normalized duration). A selection of ANOVA results are presented in this section.

There was a significant effect of SDE group for F2 of /æN/ ($F(11,832)=2.16$, $p = 0.0148$). Post-hoc tests using subset ANOVA were run to determine which SDE groups differed the most significantly. The WHT and CHN SDE groups, which in (5) are the furthest apart at time point 5 (and all other points in the vowel), were found to be significantly different ($F=13.51$, $p < 0.0001$).

The same battery of ANOVA tests was run on the data to test for effects of ethnicity, background language, and caregiver language on the formant values of /u/. The one-way repeated measures ANOVA did not find significant differences between ethnic groups for F2 at timepoint 5 (time-normalized midpoint). However, another ANOVA run for time point 2 of that vowel (approximately 25% of normalized vowel duration) found a significant difference ($F(11,2337)=2.094$, $p = 0.018$) in F1. This is broadly consistent with the SSANOVA model's findings of a strongly time-varying effect on the F1 of /u/ that is limited to the beginning portion of the vowel. Post-hoc tests using subset ANOVA showed that WHT and VTM speakers differed significantly at an alpha level of $p = 0.005$, as well as JPN versus CHN speakers ($F=4.201$, $p = 0.041$) and VTM versus CHN speakers ($F=4.653$, $p = 0.032$).

The ANOVA conducted on the midpoint F2 values of /ou/ also found ethnicity to be a significant predictor ($F(11,2794)=3.233$, $p < 0.001$). Post-hoc tests using subset ANOVA showed that WHT

²Data from the remaining five SDE groups—JPN, FLP, MDE, SOU, and HAP—are not reported here, but our complete data is available upon request.

speakers' F2 values of /ou/ differ significantly from BLK, LAT, and CHN speakers ($p < 0.001$, $p < 0.001$, and $p = 0.012$, respectively). Similarly, BLK speakers had significantly different F2 values from KRN ($p = 0.001$) and LAT speakers ($p = 0.027$). (16) summarizes these results.

(16) *Post-hoc tests for inter-ethnic differences in F2 of /ou/*

SDE / Vowel	/ou/ F2
WHT-BLK	F=11.49, $p < 0.001$
WHT-LAT	F=13.18, $p < 0.001$
BLK-KRN	F=10.63, $p = 0.001$
BLK-LAT	F=4.917, $p = 0.027$
WHT-CHN	F=6.331, $p = 0.012$

Furthermore, repeated measures ANOVA tests found that ethnicity was a significant predictor of F1 of /ε/ (F(11, 2300)=2.114, $p = 0.017$), which in CVS is lowered (as well as backed). When comparing WHT speakers to BLK and LAT speakers using a subset ANOVA as a post-hoc test, both were found to be significant ($p = 0.042$ and $p = 0.088$, respectively), corroborating the SSANOVA model's findings that these two groups lag in comparison to WHT speakers in the changes that are occurring with front vowels in CVS.

Lastly, the ANOVA tests also showed that the F1 of /ε/ varied significantly by background language (F(6,1268)=2.35, $p = 0.029$), as did the F2 of pre-nasal /æN/ (F(6,458)=2.321, $p = 0.032$). A subset ANOVA post-hoc test was run comparing English-Mandarin bilingual speakers and English-Cantonese bilingual speakers and found a significant effect of background language on /æN/ F2 (F=9.402, $p = 0.002$). There was also a significant difference found when comparing English-Mandarin bilingual speakers and English monolingual speakers (F=8.834, $p = 0.003$). No significant difference was found between English-Cantonese bilingual speakers and English monolinguals. These were the only significant results found with respect to demographic factors outside of self-determined ethnicity.

4 Discussion

4.1 Low front vowel raising, ethnicity, and L1 phonology

This work attempts a large-scale sampling across the internal diversity of Californian English. Results suggest that ethnic subgroups of the population exhibit distinct patterns of CVS adoption. Raising and fronting of pre-nasal /æ/ (HAND-raising) is one such example: our results suggest that the degree of raising and the steepness of the F2 trajectory of the vowel vary by ethnicity. White and Black speakers exhibit higher initial F2 and lower initial F1 values for this vowel, characteristic of advancement in the direction of the CVS; most other groups lag behind them, notably the Latino and Korean groups. Outside of the nasal coda environment, speakers tended to back /æ/ (TRAP-backing), a common characteristic of CVS. Yet these changes were not consistent across ethnicities either. In fact, the Korean participants, who lagged in HAND-raising, demonstrated some of the highest rates of TRAP-backing. This supports previous accounts of minority communities in California participating in well-known sound changes of the majority (White) community (Fought, 1999; Hall-Lew, 2009).

While White and Black speakers showed more HAND-raising, they showed less TRAP-backing. Likewise, while Korean speakers lagged in HAND-raising, they led in TRAP-backing. Consequently, the location of /æ/ in acoustic space may differ between Korean and White or Black speakers, but all trajectories are broadly similar across groups. The sole exception to this generality was the

Latino speakers who lagged in both HAND-raising and TRAP-backing. For these speakers, it would appear that /æ/ is not undergoing an allophonic split to the extent of White, Black, or Korean speakers.

We must also factor in the linguistic environment of speakers in the Voices of Berkeley corpus, which may be correlated with ethnicity. For example, the patterning of /æ/ in Korean-identified Californian English speakers can be attributed partly to the role of Korean phonology (regardless of the speaker's linguistic status—recall that not all study participants were bilingual or heritage speakers). Many Californians of Korean descent may have been exposed to the language in childhood. Although they may or may not be bilingual as adults, phonetic categories are established from a young age (Werker and Tees, 1984; Kuhl, 1991) and have a lasting effect on acquisition, perception, and production in the L1 and subsequent L2s (Broersma, 2016).

The role of ambient caregiver language, even when not acquired by children, is well documented. The differences by ethnicity between Korean and White/Black participants that variables such as /æ/ demonstrate can be attributed to the linguistic experiences of many of the Voices of Berkeley participants. That White and Black speakers patterned similarly is not surprising. AAVE and varieties of White American English certainly differ, but still have more overlapping vowel phonemes than English and Korean (Thomas, 2007): for instance, the latter does not have phonemic /æ/. Though all participants were native English speakers, bilingual and heritage phonology research has demonstrated the effect that two languages have on one another in bilingual/heritage speakers' phonologies (Flege and Port, 1981; Flege, 1991; Kehoe et al., 2004; Chang, 2010).

Given their tendency to back /æ/, we could propose that Korean speakers produce an intermediary /æ/ value between English /æ/ and Korean /a/. (This is already a well-documented variant in Chicano English, though orthographic correspondence between English /æ/ and Spanish /a/ certainly plays a role in this; see below). The absence of an /æ/ category in Korean, even if the participant does not speak the language, could cause a distinctive shift in the acoustic mapping of English /æ/. Further perception studies would need to examine this proposition in more detail.

Unlike Korean participants, the Latino group showed an overall reduced acoustic /æ/ space. The F1 and F2 values lagged behind other speakers for nasal /æ/ raising, a finding that supports previous accounts of Chicano English in California. However, the Latino group also had higher F2 values for the non-nasal /æ/ than the most advanced ethnic groups (i.e. less TRAP-backing), which contradicts other accounts of Chicano English in California that found that these speakers exhibit *more* TRAP-backing than their White peers. This finding is often attributed to 'Spanish interference' (Eckert, 2008b, p. 34).

The source of this variation in Chicano English is clear: as in Korean, /æ/ is absent from the five-vowel Spanish system. Furthermore, orthographic English /æ/ corresponds to Spanish /a/. Yet the previous finding of increased TRAP-backing in Latinos was not supported in our analyses. Consequently, we propose that the TRAP-backing sound change no longer uniquely indexes Chicano speakers, a change that Eckert predicted. The Chicano pattern of TRAP-backing has become so ubiquitous, and indexes Chicano speakers so strongly, that it may now permit additional indexical fields, even those that are not exclusively Chicano (Mendoza-Denton, 2014). The Korean group, and to a lesser extent the Chinese, now exhibits the most TRAP-backing. Further sociolinguistic investigation is required to validate this preliminary finding, but our analyses do suggest that the distinctive Chicano TRAP-backing is not unique to this ethnic group, and, moreover, the Latino group does not even participate in the sound change as much as other groups.

4.2 Back vowel fronting, ethnicity, and heritage language

For back vowel fronting, once again, results varied by self-determined ethnicity. The dichotomy between Black and White participants and Korean and Latino was still present for /oʊ/: Black and White participants had higher F2 values than other groups, while Korean and Latino participants had the lowest. Much of this variation can again be explained in terms of heritage language phonologies. Like /æ/, /oʊ/ is absent in both Korean and Spanish, but /o/ is not. While White and Black participants, generally not exposed to the phonologies of other languages from a young age, front /oʊ/, Korean and Latino participants may assimilate their /oʊ/ vowel to /o/. This could result in an intermediary category between /oʊ/ and /o/: that is, a retracted /oʊ/.

While this explanation of heritage language phonologies may explain inter-group variation in /æ/ and /oʊ/ patterning, /u/ appears to compromise the reasoning. White speakers, with the highest F2 values, still lead in this vowel change, but Korean participants also lead. (Black participants lag only slightly behind this.) One possible explanation for Korean /u/ fronting is based in L1 phonology: Korean has two phonemic high central unrounded vowels, /u, uː/ (in addition to its high close vowels /u, uː/), and as argued in Section 4.1 above, the presence of this category in speakers of Korean or in people who were highly exposed to Korean as children, can affect the realization of several English vowels.

This logic may seem contradictory. After all, we find that Korean speakers exhibit more TRAP-backing precisely away from the large presence of mid front vowels. Now, it appears that they do exactly the opposite, exhibiting /u/ fronting as the possible result of the categorical pull of /u, uː/. This raises an interesting question: why do some Korean vowel categories appear to result in English vowel assimilation while others repel it?

The number of categories aside, the answer may rest in the social hierarchy of CVS. Korean-identified Californians participate widely in TRAP-backing and /u/-fronting, but not HAND-raising or /oʊ/-fronting. This pattern aligns most closely with that of another group: Latino and/or Hispanic-identified Californians, many of whom may speak Chicano English. Previous work has documented the prevalence of /u/-fronting (Fought, 1999) and TRAP-backing amongst Chicano English speakers (Eckert, 2008b; Mendoza-Denton, 2014). These changes are also common amongst White and Black ethnicities, but it would appear that Korean speakers only participate in those changes that are attributed to another ethnic minority. As discussed for the Latino group above, attribution does not entail usage: TRAP-backing is indicative of Chicano English speakers, but our Latino group did not participate in this change to the same extent as other groups.

Still, it could be that Korean Californians are participating only in changes that are associated with the largest ethnic minority in the state. Further research may even determine if the similarities between the two groups are correlated with geographic location: it is plausible that Koreans and Latinos who, for example, live in bordering communities in urban Southern California will influence each other's speech. This could explain the otherwise confounding distinction between Korean participation in /u/-fronting and TRAP-backing but their reduced /oʊ/-fronting and HAND-raising. All four are well-documented sound changes in CVS, but it is only through the lens of ethnolects in contact that we can propose explanations for the unique phonetic patterns of individual ethnic groups.

4.3 Language background and ethnicity

For the most part, it seemed that Chinese-identified participants in the Voices of Berkeley corpus appeared to be the most 'average' Californians in that their participation in the various characteristics of CVS neither led nor lagged behind the other ethnic groups. Without deep ethnographic

study we would only be able to list the many reasons why this may be the case.

However, it is important to note that ‘Chinese’ as one large ethnic group is neither accurate nor ideal. Despite the SDE groups coming from participants’ own decisions, we have seen that the differences among ethnic groups can be influenced largely by a non-English language that is associated with that ethnicity. Our one-way repeated measures ANOVA showed significant differences in /æN/ when comparing Chinese Californians who speak Mandarin and Chinese Californians who speak Cantonese. These two languages have very different phonologies, and the communities that speak them often live in different geographical environments and have different immigration histories. Although our study has focused on ethnicity as the primary predictor of varying participation in CVS, we necessarily conclude that ‘ethnicity’, for the purposes of sociolinguistic inquiry, is more complex than the traditional ethnic categorizations we are all accustomed to, which we may take for granted.

5 Conclusion

The California Vowel Shift represents several phonetic sound changes in progress. However, our results have demonstrated that not all Californians participate equally. Sociodemographic factors such as ethnicity and language background are significant predictors of how an individual’s vowel space will adhere to previously-identified CVS patterns. Our knowledge of CVS has developed beyond the original findings to include the reality of California’s diversity, which underscores the importance of including ethnicity as a sociolinguistic variable and avoiding the generalization, particularly in multietnic regions such as California, that White American English is the norm.

Future work in this field can build on these findings; this study is an excellent starting point for determining the meanings of sociolinguistic variables, such as whether the F2 values of non-raised /æN/ or highly-backed /æ/ are linked indexically to certain Californian Asian identities, and in particular how TRAP-backing has traveled as a sociolinguistic variable from Latino identity to other ethnic identities. In-depth ethnographic work would help elucidate the social meanings of these variables. Such a methodological tool is especially important as the relationship between ethnicity and language are complex, historically dependent, and particular to different communities.

A Production stimuli

The following sentences were used in the collection of corpus data. They are shown with corresponding ARPABET transcriptions of vowels used in acoustic analysis. The sentences are slightly modified from sentences taken from the TIMIT database.

1. Go Bears!
OW EH
2. Dawn found it odd that Judd did a handstand.
AO AW IH AA AH AEN-AEN
3. She had your dark suit in greasy wash water all year.
IY AE UH AA UW IH IY AA AO AO IY
4. Who said you should hold such an awkward pose?
UW EH UW UH OW AH AA OW
5. Don was awed by the hat rack.
AA AO AY AE AE
6. This wheel’s red spokes show why mud is no boon.
IH IY EH OW OW AY AH OW UW

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